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ABSTRACT

A subtle revolution in the goals and methods of education, which has been occurring in the United States since the early 1960s, emphasizes both creative problem solving and creative expression. This booklet discusses this creativity and explores the evidences of change in educational objectives, teaching methods, curriculum and instructional materials, procedures for identifying creative talent, and the assessment of creative achievement. The booklet also deals with creativity at different educational levels, measuring creative thinking abilities, the pattern of development of creative abilities, creative ways of learning, what teachers can do, planning learning experiences for creativity, the teachers' own creativity, and goals in guiding creativity. A list of selected references is included. (JM)

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What Research Says to the Teacher

Creativity in the Classroom

by E. Paul Torrance

nea
National Education Association
Washington, D.C.

CS 203 115

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INTRODUCTION

Since the early 1960's, there has emerged a quiet, subtle revolution in the goals and methods of education in the United States. This revolution has been in the direction of greater emphasis on both creative problem solving and creative expression.

Revolutions are usually explosive and violent. But this one has been so quiet and subtle that many educators will be surprised to learn that it has occurred and is still occurring. To realize that such a revolution has occurred, a person must compare the textbooks used in elementary and secondary schools in the early 1960's with those in use now. One must compare instructional materials, magazines for teachers, college textbooks in education, instructor guides to the use of textbooks, statements of teacher objectives, teacher procedures for assessing the attainment of objectives, learning activities used in arriving at these objectives, procedures used in identifying gifted and talented students, and the like. (27, 33, 35)*

This revolution was underway in the early 1960's, but little of the retooling mentioned above had taken place. Already it seemed possible that many things could be learned in creative ways (by searching, exploring, guessing, testing, retesting, combining, synthesizing, etc.) more effectively and economically than by authority (being told, accepting without questioning, doing only what is prescribed by someone else, etc.). It appeared that children could be taught so that their creative thinking abilities would be useful in acquiring traditional educational skills as well as problem-solving skills, that these abilities were different from those measured by traditional intelligence and scholastic aptitude tests, and that these abilities were important in mental health and career success. Many education leaders were seeing in creativity research findings a demand for revolutionary changes in educational objectives, curriculas, instruments for assessing cognitive and affective growth and educational achievement, instructional procedures, counseling and guidance procedures, supervisory and administrative practices, and even in school building planning and utilization. The research evidence was incomplete and is still incomplete. However, in the early 1960's it was sufficient to provide the clues for many of the changes that have since occurred. (23, 24, 25, 26, 29)

*Numbers in parentheses appearing in the text refer to the Selected Research References beginning on page 34.

First, let us examine what is meant by creativity and the nature of the changes that have occurred and then look at the status of the knowledge upon which these changes are based and additional changes that are likely to occur in the near future.

CREATIVITY

Some degree of creativity occurs whenever people solve problems for which they had no previously learned or practiced solution. Some solutions like this require only tiny creative leaps while others call for genuine breakthroughs in thinking. All of them require that the individuals "go beyond where they have ever gone before."

Creativity has usually been defined in terms of either a process or a product and at times has also been defined in terms of a certain kind of personality or environmental condition. The author has chosen to define creativity as the process of sensing problems or gaps in information, forming ideas or hypotheses, testing and modifying these hypotheses, and communicating the results. This process may lead to any one of many kinds of products—verbal and nonverbal, concrete and abstract. Under this definition, it is possible to subsume the major elements of most other definitions. The production of something new or original is included in almost all of them. Creativity is sometimes contrasted to conformity and is defined as the contribution of original ideas, a different point of view, or a new way of looking at problems; whereas, conformity is defined as doing what is expected without disturbing or causing trouble for others. Creativity has also been defined as a successful step into the unknown, getting away from the main track, breaking out of the mold, being open to experience and permitting one thing to lead to another, recombining ideas or seeing new relationships among ideas, and so on. Concepts such as curiosity, imagination, discovery, innovation, and invention are also prominent in discussions of creativity, and sometimes one or the other is equated with creativity. Some insist that every act of adaptation may be regarded as creative behavior. (28, 30)

When creativity is defined as a product, the results of the process are embodied in an invention, a scientific theory, an improved product, a literary work, a musical composition, a new design, or the like. In the child, it may be the discovery of a new relationship in nature (new to the child, at least), a song, a poem, a story, or some unusual contraption or

gadget. At the highest level, it is required that a creative idea be true, generalizable, and surprising in the light of what was known at the time the idea was produced. The U.S. Patent Office requires that a patentable device measure up to some standard of inventive level, characterized by such qualities as (1) a high degree of creative strength, (2) usefulness in the sense of being a "stride forward," and (3) newness associated with overcoming a difficulty, prior failure to solve the problem, prior skepticism, and novelty of instrumentality. (26) In a less stringent sense, these criteria can be applied to the productions of children and young people.

EVIDENCES OF CHANGE

Many educators have not fully recognized that changes in the direction of a more creative education have occurred. Many educators are so unaware of the changes that have occurred in the goals of education in the United States that they are continuing to evaluate educational achievement by the same measures and same objectives we had over twenty five years ago. There has been a widespread outcry that children in today's schools are not learning as much and that they are not as intelligent as they used to be. These educators do not realize that needs have changed, textbooks have changed, teaching methods have changed, and the goals of education have changed. The parents of almost any schoolchild, however, will tell you that their child has more information and more sophisticated skills for finding out and can solve more difficult problems than they could at a similar age. Today's young people are still setting new records, not only in athletics as in the Olympics but in scientific discoveries, musical composition, and in almost every other creative area. In studies recently undertaken, the author is finding that children in today's schools are functioning at a higher level of creative thinking as assessed by tests than they were even 10 years ago.

What are some of the changes that have occurred?

Objectives of Education

On the basis of personal observations of what occurs in schools, reports by others of what goes on in schools, observational records of doctoral students, and professional literature in education, there is little doubt in

the author's mind that enormous changes have taken place in the objectives of education. In 1960, surveys of the objectives of social studies teaching rarely showed any attention to the development of thinking skills of any kind. (29) Graduate students and researchers who wanted to study problem-solving behavior and creativity in classrooms did not find enough of such behaviors to study. Observations of classroom behavior with checklists including such behaviors failed to reveal enough tallies to warrant statistical analysis. Such studies had to be abandoned for lack of data. Now such studies are common. In 1973, Torrance and Torrance reviewed 142 experiments in elementary and secondary schools designed to facilitate the development of creative thinking. All of these studies were conducted since 1960. (39)

Teaching Methods

Similarly, there is little doubt that teaching methods have changed and that there have been significant changes in the nature of teacher-pupil relationships. For several years, it seemed that the widespread enthusiasm for behavior modification and a preoccupation for controlling the behavior of children would cancel out efforts in the direction of more creative teaching. Now there seems to be a shift to a more balanced position concerning the teacher-pupil relationship. In fact, the behavior modification movement has focused attention on responding to the student and the creation of a more responsive environment, a characteristic deemed essential to the establishment of a creative teacher-pupil relationship.

There are now numerous textbooks, modules, films, tapes, and other materials for use in teacher education programs to develop competencies for creative teaching. Unfortunately, many of these remain in mimeographed stages and have not attained widespread use in teacher education programs. An interesting example of such teaching training materials is the course units developed by the Open University of Great Britain (available in USA from Harper and Row). This package of materials contains a syllabus, cassette, and a package of problems, tests, and activities to develop teaching skills.

Perhaps the most elaborate and complete package for training teachers in the skills of creative teaching is one developed by Frank E. Williams. (41) It contains two cassettes, an extensive set of posters, a set of prompting cards to use in generating teaching ideas to develop creative

thinking, an instructor's manual, a book on identifying and measuring creative potential, one on encouraging creative potential, a workbook for practicing creative teaching skills, a media resource book, and a volume of classroom ideas for encouraging thinking and feeling.

Teaching methods have also been influenced by the teacher guides and pupil workbooks which are a part of the new curricular materials that have been developed by various educational publishers in such areas as reading, social studies, science, art, mathematics, music, and the like. A good example of such an effort is found in the Ginn Reading 360 and 720 series. (3, 4) For the authors and editors of this reading program, the author developed guidelines concerning the kinds of activities that might be used before, during, and after lessons to facilitate creative thinking and the kinds of skills that might be expected to develop at various stages. Both the usual field tests and empirical studies concerning the evaluation of this program have been encouraging. The indications are that the materials do facilitate changes in teacher behavior and result in creative pupil behavior. For example, the field tests indicate that the use of this reading program has increased utilization of library books and pupil activities to obtain additional information through experimentation, interviewing people, etc. A common observation has been that reading becomes more fun for both teachers and pupils.

Curriculum and Instructional Materials

Perhaps the most visible of the retooling efforts has been the production of curriculum and instructional materials designed to facilitate creative thinking. The earlier developments in this area such as the Myers and Torrance idea-books cut across all curricular areas and were not tied into existing curricular patterns. (17) The Cunnington and Torrance Imagi/Craft materials moved in the direction of more traditional curricula (history, geography, science, reading) but still involved all curricular areas of the elementary school. (36) The Purdue Creativity Program, the Covington-Crutchfield-Davies Productive Thinking Program, Gordon's *Making It Strange* series, and Renzulli's *New Directions in Creativity* program are somewhat similar in their relative independence of traditional curricula. (5, 7, 20) All of these programs, however, have been used rather widely in programs, and experimental evaluations have been favorable. As publishing ventures, their volume of sales has been too modest to keep some of the educational publishers interested. Some of

these programs are out of print. Even the use of more traditional curriculum packages has been handicapped by limitations imposed by textbook adoption practices of many states, but their use is quite widespread.

One can gain a rough idea of the status of creativity curriculum instructional materials by examining the advertisements in professional magazines such as *Instructor*, *Learning*, and *Early Years*. The May-June 1976 issue of *Instructor* contains advertisements of such materials for 38 publishers. The May-June 1976 issue of *Learning* contained 27 such advertisements, and the September 1976 issue of *Early Years* contains 28. These advertisements now treat the creative aspects of their curricular materials in a low-key way and as a matter of course. The creative aspect of curricular materials is so well integrated that one must read carefully to identify this characteristic in the advertised materials. This is in contrast to what was occurring even two years ago when the August-September 1974 issue of *Instructor* contained advertisements of creativity instructional materials by 47 different publishers. In most of the 1974 advertisements, the creativity element was highlighted and featured. Today's advertising rarely uses the term "creative" and instead describes various kinds of thinking, problem-solving, and imaginative kinds of activities.

Practically every curriculum reform during the past 20 years has moved education in the United States closer to a more creative kind of education. The present national and international interest in career education and futures studies is especially promising. Creative thinking is at the very heart of both of these educational reforms. In fact, neither of them can gain any headway without giving top priority to the development of skills in creative thinking and problem solving. (13, 14, 35)

In career education, it is only through the mobilization of students' creative thinking that the fusion among school learning, the world of work, and understandings of personal characteristics of a student can occur. In almost all of the curricula thus far produced, there is great emphasis upon seeing implications, producing alternatives, predicting trends, predicting the consequences of decisions, elaborating alternatives, asking questions, decision making, obtaining new information, recognizing and understanding one's own potentialities, changing one's own characteristics, and the like. There is a strong element of creativity in all of these, and there is a future orientation in them, as well.

Career education represents a creative synthesis of traditional educa-

tional goals, creativity, self-awareness, and futurism. This synthesis or fusion may be illustrated by one of the key objectives of education—that of helping children see and develop clear relationships between what they are asked to learn in school and their potential future careers. It is concerned basically with developing in children such intellectual skills as seeing problems, seeing implications, asking pertinent questions, becoming aware of possible consequences, making predictions, producing divergent implications, and elaborating upon given information. In applying these intellectual skills to teaching at the primary level, a teacher would help children become aware of the importance of being able to do such things as read, write, and speak effectively. To do this, involves helping children learn about their futures in ways that are meaningful to them.

At the primary level, the teacher must also develop positive attitudes about learning and an awareness of subject matter in classroom and playground activities, home, and community. Again, this calls for creative thinking in seeing the connection between (1) what is read in books, seen in pictures and films, and the like, and (2) the problems that occur in classroom, playground, community, and home.

At the intermediate level, the teaching would increase the child's awareness of the subject matter relevance through applications to home, community, and specific worker examples. There would be a beginning awareness of educational alternatives and their implications.

At the middle school level, the teacher would help children apply subject matter in a career context in simulated and actual work settings, become aware of educational alternatives, and see relationships of these alternatives to potential careers.

At the high school level, teachers would work for increasing the application of information in simulated and actual work settings, increasing the knowledge of educational alternatives and relationships to potential careers, and developing the necessary competencies for continuing education.

Thus, at every stage there is a great deal of practice of creative problem solving within the context of a future orientation.

Procedures for Identifying Creative Talent

A variety of test and observation procedures have been proposed for identifying creative talent. In 1960, the author pointed out that identify-

ing as gifted those students who score in the upper 20 percent of an intelligence test is to disregard 70 percent of the most creative, as similarly identified by a creativity test. This generalization was based on the testing of several school populations in 1958 and 1959. A recent check of several school populations in the 1970's indicates that this still holds true. (32, 33)

In 1960, there were no commercially available tests for identifying creative talent among schoolchildren. Today, several such tests are available commercially and a variety of others are in various experimental stages. Perhaps the most widely used test battery is the *Torrance Tests of Creative Thinking*. (32) Considerable reliability, validity, and normative data have now accumulated on these tests. The prevailing evidence indicates that the performance of high school students on these tests is related significantly to adult creative achievements as determined 12 years later. The relationship between performance on these tests and tests of intelligence continues to be generally positive but low. There seems to be little or no racial, socio-economic, and sex bias in the tests. Individual differences in performance appear to be a function of experience rather than heredity. Several states have approved the use of the *Torrance Tests of Creative Thinking* for use in identifying students for participation in certain state-supported programs for gifted students, e.g., in New Mexico and Illinois.

Less well-validated is *Thinking Creatively with Sounds and Words* by Torrance, Khatena and Cunnington (37) and unpublished batteries for young children such as *Mother Goose Problems Test, What Can It Be?* and *Thinking Creatively in Movement and Action*. Currently under development by Torrance are *Thinking Creatively about the Future* (high school and college levels) and *Thinking Creatively about Learning and Teaching* (college and adult levels). Also under development are guides for a streamlined scoring of the basic battery *(Torrance Tests of Creative Thinking*, Verbal and Figural Forms A and B). Preliminary indications are that this scoring procedure can be mastered rather readily by classroom teachers and yields more useful information to teachers than the more elaborate and precise scoring procedures that are now being used.

A battery of *Creativity Tests for Children* developed by J.P. Guilford has recently become available for use with children from grades 4 through 6. Prior to this time, tests by Guilford for older children and adults have been available as a part of the instruments developed in connection with

his *Structure of Intellect Model* (available from Sheridan Psychological Services, Inc.). (12) Although not generally available, Wallach and Kogan's (40) battery of creativity tests has been made available to some investigators. At the college level, the *Remote Associates Test* (RAT) by Mednick and Mednick (16) has been used. Performance on this test, however, shows very little relationship to performances on the open-ended type of creativity test. Indications are that it is more of a test of convergent than of divergent ability.

There has been relatively little retooling of instruments for the study of creative personalities. Major dependence has been placed in such established instruments as the *California Personality Inventory*, the *Omnibus Personality Inventory*, Cattell's *16 Personality Factor Test*, *Runner Studies of Attitude Patterns*, *Rorschach Ink Blots*, *Myers-Briggs Type Indicator*, and the like. There have been developed a few brief screening instruments, such as, Torrance's "Creative Motivation Scale" and "What Kind of Person Are You?" and these have produced promising and interesting findings. Perhaps the major retooling effort in the personality domain has been the development of biographical and life experience inventories. The ones developed by Calvin W. Taylor and his associates have definitely been criterion-referenced for creativity criteria. The *Alpha Biographical Inventory* for high school students is perhaps the most widely used of these. (6)

Assessment of Creative Achievement

Perhaps the weakest link in the retooling of education for creative talent is the paucity of instruments for the assessment of creative achievements. Researchers have used a variety of checklists, indicators of real-life creative achievements, and the like, but there have been no really systematic, comprehensive, and sustained efforts to develop procedures for assessing creative achievement in the basic subject-matter fields. There have been scattered, short-term efforts, but these cannot be expected to satisfy the needs. One of the more sustained efforts is D.M. Johnson's work at Michigan State University in evaluating productive thinking in psychology courses. (15) The author has experimented with a variety of approaches for assessing creative achievement in educational psychology courses and various kinds of workshops and in-service education. However, these have not been systematic and sustained and have not resulted in published, standardized instruments.

CREATIVITY AT DIFFERENT LEVELS

Preschool and Early Childhood Years

Many scholars used to deny the possibility that young children could do productive thinking (producing something from what is cognized and remembered), and this has led to an overestimate of the child's receptivity. This misconception has led to an overemphasis upon the importance of providing a responsive environment, an emphasis upon recall and reproduction to the neglect of problem solving, creative thinking, and decision making. (30, 38)

The beginnings of creative thinking may be found in the manipulative, exploratory, and experimental activities of the infant and the use of facial expressions, efforts to discover and test the meaning of facial expressions and gestures of others, and the like. When a child first comes to school, the creative skills learned through such efforts are ready for use in acquiring new educational skills and information. (31)

Of the many manifestations of creativity during the elementary school years, greatest attention has been given to creative writing and art. We are now having a renewed recognition of the value of children's writing and art and discovering that children can be creative in a variety of other ways which are also important. Generally, educators of the past have considered children in the elementary and even in the high school years to be incapable of creative scientific thought. Thus, until recently the introduction of science into the curriculum has been delayed until high school, and even then it was taught as a body of accumulated knowledge to be transmitted by authority and not as a way of thinking or discovery and inquiry. The picture has now changed. Science has been added to the elementary curriculum in such fields as history, and children are being taught the thinking skills of the historian. Similar developments have occurred in anthropology, geography, psychology, and sociology.

High School Years

A number of teenagers have made history with their inventions, scientific discoveries, and other creative contributions. Among them are Arturo Toscanini, Wernher von Braun, Samuel Colt, Louis Braille, Galileo Galilei, and Edna St. Vincent Millay. Each year, a number of

notable inventions and discoveries are credited to high school youths. High schools have long had provisions for recognizing creative writing and speaking talent, and in recent years they have begun making provisions for recognizing scientific and inventive talent.

The following five manifestations have been recognized in the Creative Science Scale that the National Merit Scholarship Corporation uses in its work: (28)

1. Giving an original paper at a scientific meeting sponsored by a professional society
2. Winning a prize or award in a scientific talent search
3. Constructing scientific apparatus on own initiative
4. Inventing a patentable device
5. Having a scientific paper published in a science journal.

The Creative Arts Scale gives credit for such manifestations as published poems and articles; awards in speech contests; prizewinning sculpture, ceramics, and painting; musical compositions and arrangements which have been publicly performed; dramatic performances; literary awards and creative writing prizes; and cartoons published in public newspapers or magazines.

College Years

Undergraduate college students have been known to produce almost all types of creative products, such as, inventions, medical discoveries, books, monographs, dramas, and operas. Usually, however, such accomplishments have been achieved outside of college requirements and sponsorship. Dissertations and theses, usually regarded as original contributions, tend to be evaluated in terms of correctness of methodology rather than in terms of originality, power, and worth of the ideas developed and tested. Through honors programs and other provisions for individual investigations, efforts are being increased to change this picture. Also, there have always been outstanding exceptions to the generalizations just expressed. Medicine, for example, has a rich tradition of important discoveries that were made by undergraduate students.

MEASURING CREATIVE THINKING ABILITIES

During the past 100 years, a variety of procedures have been developed for measuring some of the creative thinking abilities. Most of these measures have been used only in research, and only now are tests of creative thinking abilities becoming available for use in schools. It should be made explicit at this point that the weight of evidence indicates that creative thinking is not a unitary ability, but that a number of abilities are involved. (11, 27) According to the most extensive research in this field, the abilities involved are sensitivity to problems, fluency (the ability to produce a large number of ideas), flexibility (the ability to produce a variety of ideas or use a variety of approaches), originality (the ability to produce ideas that are off the beaten track), elaboration (the ability to fill in the details), and redefinition (the ability to define or perceive in a way different from the usual, established, or intended way, etc.).

Recently, the author has developed and begun validating scoring procedures for assessing resistance to premature closure, ability to produce abstract titles for pictures, unusual visual perspective, internal visual perspective, articulateness in telling stories through drawings and captions, humor, movement, and the like. As our understanding of creativity emerges, additional scoring categories will come into use.

As had been anticipated, these tests (especially the *Torrance Tests of Creative Thinking)* have incited a considerable amount of controversy. Perhaps the most common misunderstanding has sprung from the assumption that the Torrance tests (the author's) attempt to measure a unitary ability. Torrance is convinced that people may be creative in an almost infinite number of ways. This creates quite a problem for the test maker. Torrance's resolution of the problem was to try to sample in practical ways some of the most important kinds of thinking involved in creative behavior. He was never concerned that these measures correlate highly with one another. His major concern was that they correlate with real life creative behavior and that they be in harmony with the concept of creativity. The tasks included in the *Torrance Tests of Creative Thinking* were devised so that they reflect different aspects of creative behavior; that is, kinds of cognitive-affective behavior that facilitate effective creative functioning. This was accomplished primarily by (a) analyzing the behavior of eminent creative people as recorded in autobiographies

and biographies as well as experimental studies of the creative problem solving process, and (b) subjecting scores derived from a wide variety of test tasks to factor analyses and selecting tasks that were factorially different. In summary, the criteria for selecting specific tests and testing materials are as follows: (27, 32)

1. They must have relevance to creativity theory.
2. They must have relevance to adult creative behavior in the real world.
3. Each one must sample a different aspect of creative behavior.
4. They must be attractive alike to children, adolescents, and adults.
5. They must be open-ended so that a person can respond in terms of his/her experiences whatever these may have been.
6. The instructions and response demands must be adaptable to the educational range from kindergarten through graduate and professional school.
7. They must yield data that can be scored reliably for meaningful aspects of creative thinking.
8. The testing materials, instructions for administration, time limits, and scoring procedures must be such that the use of the standard batteries in schools is feasible.

Perhaps no test in the history of psychological measurement has been subjected to so many experiments in methods of test administration, time limits, and testing conditions. Torrance has welcomed these, and he and his students have engaged in a considerable number of these studies. In fact, it is regrettable that a great many other educational and psychological tests have not been subjected to such tests. Many test authors, however, become enraged if any one administers their tests in a way different from what they have prescribed.

Some critics of the *Torrance Tests of Creative Thinking* have repeatedly declared that they are not different from intelligence tests. The author and his associates have continued to study the relationships between measures derived from these tests and from tests of intelligence, and they have continued to find correlations quite similar to those reported in *Guiding Creative Talent* in 1962. The mean correlation for the figural tests and tests of intelligence approaches zero and the mean correlation for the verbal tests is about .20. There are also many differences in the way scores on these two types of tests differ. The scores derived from the *Torrance Tests of Creative Thinking* correlate more highly with real life creative achievement than do measures of intelli-

gence, while the latter correlate more closely with school achievement tests. However, if school achievement is assessed by tasks requiring problem solving, application of information, etc., scores on the *Torrance Tests of Creative Thinking* are more predictive. Little or no racial or socio-economic bias is found for the *Torrance Tests of Creative Thinking*, while culturally different, disadvantaged, Black, and other minority group children perform less well on tests of intelligence than their peers in the more affluent, mainstream culture. Studies of heritability also show a difference. High heritability indexes are regularly obtained for most measures of intelligence, while there seems to be little or no heritability associated with performance on the *Torrance Tests of Creative Thinking*.

Expanded Concept of the Human Mind

Perhaps the most important consequence of the development and research use of measures of creative thinking has been an expanded concept of the human mind and its functioning. For many years, most peoples' concept of the human mind and its functioning was limited largely by the concepts embodied in intelligence tests. Developers of intelligence tests have not claimed that such tests assess all of a person's intellectual functioning. Yet, an intelligence or scholastic aptitude test has almost always been used by schools and clinics as the sole index of a person's intellectual potential. Students whose achievements fall below the level which is expected from their IQ scores are said to be "underachieving." Students achieving at an age level higher than would be expected from their IQ scores are somehow supposed to be "overachieving." Curricula and methods of teaching generally have been designed to bring about the kinds of growth or achievement related to the mental abilities involved in intelligence or scholastic aptitude tests. Tests of educational achievement likewise have been constructed along the same lines. This narrow concept of the human mind and its functioning produced a kind of education which fell short of our ideal of a humane education which would give all children a chance to realize their potentialities. (29)

By the mid-1960's a number of multiple talent models of giftedness were being offered. One of the more powerful of these is the one suggested by Calvin W. Taylor. Taylor's groupings of talent are based on world-of-work needs and specify at present academic talent and five other important types: creative (and productive) talent, evaluative or

decision-making talent, planning talent, forecasting talent, and communication talent. (27) Taylor argues that if we consider only the upper 10 percent on each talent group as gifted, the percentage of the gifted will increase from 10 percent for one talent area to 30 percent across the six talent areas. He argues further that if we limit ourselves to cultivating one of these talent groups, only 50 percent of our students will have a chance to be average (the median) in classes. If all six talent groups are considered, about 90 percent will be above average in at least one group, and almost all others will be nearly average in at least one of them.

Taylor believes that we now know enough about measuring and fostering multiple talents to find ways of cultivating most of them in school rather than letting them lie largely dormant. He also believes that in classrooms where multiple talents are cultivated all students will learn more. In other words, by having more pathways through their complex nervous system, students can use several different abilities at one time or another to process information during the school week. He believes this will happen if teachers sharpen their abilities to cultivate these talents and deliberately work across a greater number of these talents with which schools now concern themselves.

During the 1960's there was budding interest in finding hidden giftedness, especially among children born and reared in poverty and deprivation. Most of the projects designed to either discover or develop the hidden talents of disadvantaged children and youth have been effectively put down as quickly as possible. Even those short-lived, always-gasping-for-life projects have taught us much. Furthermore, there have been a few that have survived in spite of a lack of support from established sources. (31, 34)

Frank Riessman (21) was one of the first to call attention in any very powerful way to the positive talents of culturally disadvantaged children. He recognized the need for building upon the following positives:

1. Slow learning gifted children—children who appear slow because they are careful, cautious, one-tracked in their way of learning, or physical learners
2. Hidden verbal ability—very verbal out of school, articulate with peers, and articulate in role playing
3. Positive attitude toward education, though unfavorable attitude toward school
4. Enjoyment of and skill in games, physical activities, music, expressive activities

5. Cooperativeness and mutual aid
6. Avoidance of strain accompanying competitiveness and individualism
7. Children's enjoyment of each other's company
8. Informality and humor.

Building upon Riessman's work and on the basis of several years of exploratory work with disadvantaged children, primarily Blacks, this author has suggested a set of creative positives which he has found to exist to a high degree among disadvantaged children and upon which he believes we can build successful educational programs that will enable, ultimately, optimal use of potentialities. These creative positives are as follows:

1. Ability to express feelings
2. Ability to improvise with commonplace materials
3. Articulateness in role playing, creative activities
4. Enjoyment and ability in art, drawing, painting, etc.
5. Enjoyment and ability in creative dramatics, dance, etc.
6. Enjoyment and ability in music
7. Expressiveness in speech
8. Fluency and flexibility in nonverbal media
9. Enjoyment and skills in group learning, problem solving
10. Responsiveness to the concrete
11. Responsiveness to the kinesthetic
12. Expressiveness of gestures, "body language," etc.
13. Humor
14. Richness of imagery in informal language, brainstorming
15. Originality of ideas in problem solving, brainstorming
16. Problem-centeredness
17. Emotional responsiveness
18. Quickness of warm-up

The author has argued that those searching for gifted individuals among disadvantaged populations are more likely to have success if they seek them in the areas identified here rather than through the traditional ways. The author has also contended that we should give more serious consideration to careers in the creative arts and sciences for disadvantaged youth than we have in the past. When asked about their aspirations, almost no disadvantaged children express choices in the creative fields. Yet a large share of the disadvantaged persons who have attained outstanding success have done so in creative fields, and to the realization

of their human potential. In a monograph on using the creative positives of disadvantaged and culturally different students (34), the author has described how each of these positives can be used in developing both suitable curricula and career plans for students with disadvantaged backgrounds.

Recent research concerning the differential functions of the left and right hemispheres of the brain is helping to deepen and clarify the findings derived from creativity research. (18) It now seems that the left and right hemispheres of the brain process information and experience in two different modes. The left hemisphere seems to process information linearly, sequentially, and logically, and deals primarily with verbal and numerical information. The right hemisphere processes information globally, intuitively, nonlinearly, nonverbally, kinesthetically, visually, rhythmically, and deals with spatial forms, movement, sound, emotions, and other non-verbal information. The right brain seems to be the locus of our creative and artistic capabilities and our appreciation of music. Perhaps the most important insight that has come from this area of research is that there are many paths to knowing besides words. Formerly, our educational systems were geared almost totally to the development of the left hemisphere. The introduction of educational objectives which require creative thinking makes more use of the right hemisphere and should produce a greater amount of genuine learning. Insights from this line of research are also providing many clues for the more effective education of children who have different styles of learning stemming from different hemisphere preferences, especially children from poverty backgrounds.

PATTERN OF DEVELOPMENT OF CREATIVE ABILITIES

From the best research evidence available and the observations of many investigators, creative imagination during early childhood seems to reach a peak between four and four and one-half years (1) and is followed by a drop at about age five when the child enters school for the first time. Although this drop has generally been regarded as an inevitable developmental phenomenon in nature, there are now indications that this drop in five-year-olds is a societal or cultural phenomenon rather than a biological or natural one.

Findings concerning the stages of creative development during the elementary years have been amazingly consistent, considering the variety of measures, samples of subjects, and periods in history involved. In the United States, most of the creative thinking abilities as measured by tests show growth from the first through third grades, a sharp drop at about the beginning of the fourth, a rise during the fifth and sixth, and another decline at about the beginning of the seventh grade. (28, 30) The rise in the fifth grade, however, is primarily among girls and is in fluency rather than in originality. Some investigators have found that the seventh-grade decline extends into the eighth, but the writer's own studies show a rise between the seventh and eighth grades, with continued growth until near the end of the high school years, at which time there is a leveling off or a slight decline.

Studies involving deliberate attempts to keep alive creative growth in the fourth grade and studies of the development of the creative abilities in cultures outside the United States suggest that the drop which occurs in the fourth grade is a societal rather than a biological phenomenon.

In the mid-1960's, a number of studies conducted by the author and others (36) demonstrated that intelligent use of creative curricular materials could avert the fourth-grade slump in creative functioning. By 1970, results from a number of schools showed no decrement in creative thinking in the fourth grade. However, the fourth grade slump still occurs in many schools.

CREATIVE WAYS OF LEARNING

In this writer's opinion, the weight of present evidence indicates that people fundamentally prefer to learn in creative ways—by exploring, manipulating, questioning, experimenting, risking, testing, and modifying ideas. Teachers generally have insisted that it is more economical to learn by authority. Recent research suggests that many things, though not all, can be learned more effectively and economically in creative ways rather than by authority. It also appears that many individuals have an especially strong preference for learning creatively, learn a great deal if permitted to use their creative thinking abilities, and make little educational progress when we insist that they learn by authority. Such suggestions open exciting possibilities for better ways of individualizing instruction.

Learning creatively takes place in the process of sensing problems or gaps in information, making guesses or hypotheses about these deficiencies, testing these guesses, revising, and retesting them, and communicating the results. Strong human needs are involved in each stage of this process. If we sense that something is missing or untrue, tension is aroused. We are uncomfortable and want to do something to relieve the tension. This makes us want to ask questions, make guesses, or otherwise inquire. Uncertain as to whether our guesses are correct, we continue to be uncomfortable. Thus, we are driven to test our guesses, correct our errors, and modify our conclusions. Once we discover something, we want to tell someone about it.

We learn by authority when we are told what we should learn and when we accept something as true because an authority says that it is. The authority may be a classroom teacher, parent, textbook, newspaper, or reference book. Frequently it is majority opinion, the consensus of our peer group. In our democratic culture, there is a tendency to emphasize the rightness of the majority in determining the truth.

From these differentiations and from research evidence, it appears that learning by authority primarily brings into play on the part of the learner such abilities as recognition, memory, and logical reasoning—the abilities most frequently assessed by traditional tests of intelligence and scholastic aptitude. In contrast, creative learning involves such abilities as evaluation (especially the ability to sense problems, inconsistencies, and missing elements), divergent production (e.g., fluency, flexibility, originality, and elaboration), and redefinition.

Several well-known studies indicate that the creative thinking abilities can be important in educational achievement. (8, 29) It appears, however, that these abilities are less useful in classes and schools where teachers insist that children learn almost entirely by authority.

WHAT CAN TEACHERS DO?

At an early age many children appear to develop a preference for learning by authority. The human needs that make creative learning a natural process, however, appear to be sufficiently universal to make this way of learning a powerful one for all children, although not an exclusive one. What, then, can teachers do to provide the conditions in which creative thinking abilities have a predominant role?

Provide Opportunities for Creative Behavior

One of the most obvious ways of providing conditions for creative learning is to offer a curriculum with plenty of opportunities for creative behavior. This can be done in many ways. It can be done by making assignments which call for original work, independent learning, self-initiated projects, and experimentation. It can be done daily by the kinds of questions teachers ask in class and by the kinds of problems used for discussion. One study showed that over 90 percent of the questions asked by teachers of junior high school social studies courses called only for recall. Few questions called for any kind of productive thinking. Some of the new curricular materials now being developed in the form of workbooks and audio tapes and recordings will make it easier for teachers to provide opportunities for creative learning. Essentially, these materials provide progressive warm-up experiences, procedures which permit one thing to lead to another, and activities which make creative thinking both legitimate and rewarding.

The research evidence in favor of deliberate efforts to improve the quantity and quality of creative thinking are quite impressive. (9, 19, 39) Amazing records of invention, discovery, and creative solutions have been compiled through such deliberate methods as brainstorming or creative problem solving, *synectics* (a method of creative problem solving based on the idea that creative efficiency can be increased markedly if people understand the psychological processes by which they operate and that in the creative process the emotional component is more important than the intellectual, the irrational more important than the rational), and *bionics* (a somewhat similar method which relies heavily upon analogies to biological and electronic phenomena as a source of generating new ideas). The evidence from a number of experiments in educational and industrial situations also supports the value of such methods. Thus, the use of curricular materials which familiarize children with the nature of the creative-thinking process through the lives of eminent creative persons and develop skills in the use of analogy seem to be justified.

Develop Skills for Creative Learning

Learning in creative ways requires certain skills not required in learning by authority—the skills and strategies of inquiry, creative research and problem solving. (3, 5, 7, 10, 17, 19, 20, 22, 26, 38, 41)

Reward Creative Achievements

Educational research has indicated repeatedly that people tend to learn along the lines they find rewarding. If we want children to think creatively, we must learn how to reward creative behavior. We reward children not only through grades but also through the kinds of behaviors we encourage or discourage and by the way we respond to the curiosity needs of children and young people. (30, 31)

We need to be respectful of the unusual questions children ask. Nothing is more rewarding to the curious child than to find the answer to his or her question. Although lengthy delays are unnecessary, it is important to enrich the period between the question and the answer.

We must be respectful of the unusual ideas and solutions of children. Children who learn in creative ways will see many relationships that their teachers miss. Thus, the ideas presented must be evaluated before being dismissed.

We need to show children that their ideas have value. This is done by listening to their ideas, considering them, testing them, using them, communicating them to others, and giving them credit for their ideas.

We need to provide opportunities and give credit for self-initiated learning. Overly detailed supervision, too much reliance upon prescribed curricula, failure to appraise learning resulting from the child's own initiative, and attempts to cover too much material with no opportunity for reflection interfere seriously with such efforts.

We also need to provide chances for children to learn, think, and discover without threats of immediate evaluation. Constant evaluation, especially during practice and initial learning, makes children afraid to use creative ways in learning. The making of honest errors during the early stages of learning should be made less damaging to the child's record.

Establish Creative Relationships with Children

All efforts to establish conditions for creative learning may fail unless classroom teachers are able to establish creative relationships with children. The term "creative relationship" seems appropriate because the desired kind of relationship takes place in much the same way as does creative thinking. The creative relationship between the teacher and pupil

requires a willingness on the part of the teacher to permit one thing to lead to another, to embark with the child on an unknown adventure. It is also like the creative thinking process in that the teacher may work hard to establish this kind of relationship, may fervently want it, and still may fail. Then suddenly, it seems to just happen. The teacher has to be ready to accept the relationship when it happens, just as the inventor or scientific discoverer must. This aspect of the relationship, if nothing else, makes it vastly different from what is frequently referred to as permissiveness in education. The environment created by the teacher is definitely a responsive one in which the child finds adequate guidance. (28, 38)

Other Things Teachers Can Do

Although teachers must evolve their own unique ways of teaching, experimental studies show that the following principles or procedures have positive value in facilitating creative behavior.

1. Give purpose to creative writing. A number of studies have exploded the assumption that creative writing skills are developed by requiring a theme a week. Experiments in which one class wrote a theme a week that was carefully corrected while the other class read a great deal with practically no composition work have generally given a slight, though not statistically significant, edge to the reading group, insofar as composition writing is concerned. There is a difference in writing something to be corrected and in writing something to be communicated.

2. Provide experiences which make children more sensitive to environmental stimuli. One experiment shows that children can increase the clarity and vividness of their perceptions of sensory stimuli and that this affects the quality of their creative writing. Over a 10-week period, one group practiced writing vivid descriptions of pictures which they had studied; the second group studied literary models containing words of sound, color, and movement; the third group practiced describing all of the possible sensations, such as sight, smell, touch, and hearing, that they could experience in examining an object or situation. The third group showed significantly greater gains on composition tests than did the other two groups. (30)

3. Develop a constructive attitude toward the information taught. In three different experiments, students who assumed a constructive rather than a critical attitude toward available information were able to produce

a large number of creative solutions as well as more original ones. One of these experiments involved the reading of research articles and a second, textbook materials. In both, one group was asked to read material with a critical attitude, identifying defects; and the other was asked to read the material with a creative or constructive attitude, thinking of other possibilities, applications, and the like. In the third experiment, information about an industrial problem was given to participants in an industrial training program. Critical and constructive attitudes were engendered in a similar manner with similar results.

4. Provide adequate warm-up for creative activities. Experiments involving various kinds of "mind-stretching" activities have repeatedly demonstrated the value of warm-up experiences. (10, 19, 30, 38)

5. In warming up pupils for creative thinking, avoid giving examples or illustrations which will freeze or unduly shape their thinking. In many cases, the giving of examples establishes expectations which are difficult to break. This makes it difficult for pupils to get away from the obvious and commonplace in their thinking. Experiments involving creative-thinking tests show that giving examples tends to increase fluency and to reduce originality. An experiment involving the making of puppets in an art class showed that the giving of examples by the teacher reduced the originality and variability of the puppets produced by the class.

6. Avoid giving evaluative comments too frequently during practice problems or activities. One experiment showed no difference in the effects on the subsequent creativity of three types of evaluated practice (criticism and correction, suggestions of other possibilities, and a combination of these two). Too frequent use of evaluation, regardless of the type, interfered with learning and resulted in lower performance on the test task.

7. Provide unevaluated (off-the-record) practice. Young children are sometimes unproductive in responding to tests of creative thinking until they are urged to give their ideas "just for fun" or assured that "this doesn't count." In one experiment which involved two practice periods, each followed by a test task similar to the practice task, it was found that unevaluated practice led to more creative performances on the test tasks than did evaluated practice. This principle, however, seemed to be more important in grades 1 through 3 than in grades 4 through 6.

8. To evoke originality in thinking, make it clear that such thinking is expected and will be rewarded. On tests of creative thinking, children produce more original ideas when the instructions urge that they think of

ideas that no one else in the class will think of or otherwise make it legitimate for them to produce original or unusual ideas. In writing imaginative stories, children write stories which are rated as more original and more interesting when they are instructed to write such stories, paying careful attention to correctness. This illustration is also exemplified in one industrial organization whose research section had had no patents for some time. The manager expressed his disappointment concerning this record and the employees said, "Why didn't you tell us this is what you want?" After this, there was for some time a regular outburst of inventions and patents coming from the employees in this organization.

PLANNING LEARNING EXPERIENCES FOR CREATIVITY

It is now generally acknowledged that creativity does not have to depend upon chance. Similarly, learning experiences that elicit creative behavior do not have to be left to chance. They have to be planned. The author has offered a model for planning such lessons. (31) This model gives attention to the kinds of activities that may be used before, during, and after a lesson or set of learning experiences to increase the chances of creative growth. Attention is given to the purpose of learning activities at each of these stages of a lesson. Before a lesson, the major function of the activities to be planned is to heighten anticipation and create the desire to know. During the lesson, the major purpose of the learning activities to be planned is to help students dig deeper, examine information from different viewpoints, become deeply involved in the problems raised, puzzle over perplexing information, make and correct guesses, and have fun. Activities at the end of a lesson should be designed to keep the creative thinking processes going and to stimulate further efforts to obtain information and to draw insights from such information. Such activities should help students "cut holes to see through, sing in their own key, build sand castles, and shake hands with tomorrow." (3, 31)

The activities listed on the following page are a few examples of the kinds of learning activities that have been found to achieve the purposes given for each of the three stages of a lesson or set of learning experiences.

Before a Lesson

1. Confrontation with ambiguities and uncertainties
2. Heightened anticipation and expectation
3. Familiar made strange and strange made familiar
4. Looking at something from several different psychological, sociological, physical, or emotional points of view
5. Provocative questions to establish set for examining information in new ways
6. Predictions from limited information required
7. Tasks structured only enough to give clues and direction
8. Encouragement to take next step beyond what is known.

During a Lesson

1. Continued heightening of anticipation and expectation
2. Encouragement of creative and constructive rather than cynical acceptance of limitations
3. Awareness of and concern about problem heightened
4. Exploration of missing elements and possibilities made systematic and deliberate
5. Juxtaposition of apparently unrelated elements
6. Mysteries and puzzles explored and examined
7. Ongoing predictions as new data are acquired
8. Surprises heightened and deliberately used
9. Visualization of events, places, etc., encouraged.

After a Lesson

1. Ambiguities and uncertainties played with
2. Constructive responses encouraged
3. Going beyond the obvious encouraged
4. Elaborating some element through drawings, dramatics, imaginative stories, etc.
5. Search for elegant (better) solutions
6. Experimentation and testing of ideas encouraged
7. Future projection encouraged
8. Improbabilities entertained
9. Multiple hypotheses encouraged
10. Reorganization or reconceptualization of the information that is required.

TEACHERS' OWN CREATIVITY

In the early 1960's it could be said that almost no research had been directed to the problem of helping teachers understand and increase their own creativity. Since then a great variety of training programs has been developed to fulfill this purpose. However, few have been systematically evaluated. Some have sought creative growth through such procedures as Transcendental Meditation, Transactional Analysis, Creative Agressiveness Training, Encounter Groups, physical fitness programs, awareness training, and the like. One of the more systematic attempts to develop a program especially for teachers and to evaluate its outcomes was reported by George I. Brown (2) and is known as confluent education (the flowing together of the cognitive and emotional aspects of the learning process).

Since these various training procedures assist people in becoming more aware of themselves and more alive, they probably do help teachers understand and increase their own creativity. However, this author is compelled to accept the evidence which suggests that training in disciplined, deliberate methods of creative problem solving has the best batting average for success in improving creative functioning and achievement. (19, 39).

Common Difficulties in Producing Original Ideas

As a brief teacher-training procedure, the author and his associates have used with over 5,000 teachers and student teachers a set of materials entitled "Sounds and Images" that has several features built into it which have been found in other studies to facilitate the production of original ideas. (29, 37) Essentially, the materials consist of four sound effects to be used as the basis for producing word pictures or images. This set of four sound effects is repeated three times, and the listeners are urged each time to push their imaginations further and further to produce original word pictures. In some groups, we have discussed with participants the difficulties they experienced. In others, we have asked the respondents to list individually the difficulties they experienced. The following commonly recognized difficulties have also been reported by eminent creative persons and by others who have studied the creative thinking process.

1. Difficulty in finding words to describe original images. Original ideas or images are frequently too complex to put into words. Not all

creative insights can be or need to be expressed in words. Human beings respond creatively in many ways. To the pianist, the sculptor, the dancer, the surgeon, the mechanic, ideas burst into awareness in kinesthetic form, feeling their way into various kinds of muscular expression. Fingers "itch" to play; music "flows" from hands; ideas "flow" from the pen. Some participants wanted to express their images visually or kinesthetically.

2. *Inability to let the imagination "go," to laugh, to play with new ideas and materials.* After all, teachers are grown-ups. They are persons of status and must remain dignified. Many cannot permit themselves to laugh or giggle like children. Eventually, almost all of the groups engaged in some laughter, but some of them were far more grim than others. Groups of student teachers generally proved to be the most restrained. Many students of creativity believe that the ability to regress to childlike behavior (laugh, imagine, play, have fun) is an important characteristic of the creative adult.

3. *A tendency to analyze rather than synthesize.* Generally, teachers have been trained to analyze complex phenomena. The emphasis in creative thinking, however, should be on synthesis rather than analysis. We are prone to use the microscope and radar freely, to take things apart, to be scientific. Synthesis, however, is just as scientific as analysis. Analysis is useful in identifying defects; synthesis is necessary in pushing forward to a new structure of possibility.

4. *Syntheses made too quickly before all of the facts have been taken in.* In the sessions with teachers, many formed an image from the first element of the sound effect. As other elements followed, they were unable to unfreeze their first image and incorporate all of the elements in a unified image. This is why it is important that teachers permit themselves to experiment with new materials, ideas, and experiences. Teachers, like their pupils, should not feel that they have to be absolutely correct the first time, and thus miss the constant testing and revision necessary for creativity.

5. *Difficulty in freeing oneself from an earlier image.* Some of the participants who made syntheses too quickly were able to abandon the inadequate image and form a new one. Others were not. Some of them were so concerned about certainty and accuracy (what the sounds actually were) that they were unable to think creatively. A need for security or safety makes it difficult to get away from the obvious and commonplace.

6. *Fear of going too far-out in the imagination.* With each successive playing of the sound effects, the participants were urged to stretch their

imaginations further and further. A majority of them expressed a preference for their responses to the second rather than the third presentation of the sound effects. Some were afraid that they had been too imaginative. Others refused to be pushed further and only elaborated upon the first or second images produced. Some were afraid to let other members of the group see their responses to the third presentation of the sounds, lest their sanity be questioned. The fear of being an individual, of being oneself, is widely recognized as a serious block to creative thinking. It takes courage to be oneself, to think one's own ideas. Highly creative persons are not conformists in their ideas, neither are they deliberate nonconformists. Instead, they are genuinely independent in their thinking. This does not mean, however, that they are always confident about their ideas. Even the most eminent creative individuals experience feelings of doubt and misgiving.

7. *Too great a flood of ideas.* A frequent complaint of participants was that they had difficulty in writing down any image because they had too great a flood of ideas or images. This is known by creative people as the "avalanche effect" and calls for a peculiar kind of control. Creative energies must not be permitted to waste themselves. They have to be directed, slowed up, stopped, or thinned out at times. To achieve something important, the creative person has to select a small number of ideas and work them out. Some ease the tension by trapping for future use the ideas they cannot use at the moment by writing them down and filing them away.

8. *Preoccupation with worry.* Many participants confided that they were preoccupied with some worry and could not fix their attention on the problem. This is a problem to even the most creative persons. Many highly creative people are extremely sensitive, and worries about everyday affairs intensely affect their creative work. Some trivial or tiresome duty may make even a highly creative teacher unproductive.

GOALS IN GUIDING CREATIVITY

Understanding, measuring, and developing the creative thinking abilities are part of the educator's great dream of achieving a more humane kind of education in which all children will have a better chance to achieve their individual potentialities. It is of obvious importance to society that creative talent be identified, developed, and utilized.

Already, the understandings derived from research concerning the creative thinking abilities have broadened our concepts of giftedness from that of the child with the high IQ to include also the highly creative child and several other types. It is becoming increasingly clear that nothing can contribute more to mental health and the general welfare of our nation and to the satisfactions of its people than a general raising of the level of creativity. There is little doubt that the stifling of creative thinking cuts at the very roots of satisfaction in living and eventually creates overwhelming tension and breakdown. Research in progress suggests that it is important that creativity be energized and guided from birth. If it is stifled early, it will only become imitative, if it survives at all. It is true that vigorous creative imagination can survive early stifling and opposition, but if it learns only to act vigorously without direction, it becomes dangerous to society and perhaps to civilization.

It has already been pointed out that the creative thinking abilities are important in the acquisition of even the traditionally measured kinds of achievement when children are permitted to achieve some of these goals in creative ways. Their importance in vocational success has also been mentioned. Goals become clearer and more urgent, however, when we look upon the creative-thinking abilities as just one part of our expanded and expanding concept of the human mind and its functioning. An acceptance of this broader concept of the human mind opens up many new and tremendously exciting possibilities for teachers. It places a new emphasis upon consideration of what we may become. It suggests that we can educate to a higher degree many people whom we have not been very successful in educating. As we have begun to understand more deeply the creative functioning of the mind, the case for learning creatively rather than just by authority has been strengthened. This may soon enable us to learn what it really means to individualize instruction.

CONCLUSION

To convey the idea that research has solved all of the puzzling phenomena about creativity would be the grossest of errors. There are many more questions that need to be answered before we have a fully adequate scientific base for guiding creativity. However, we know enough from research to enable us to do a far better job than we are apparently doing in achieving even the most widely accepted goals of

education. No matter how much we learn from research, the individual teacher's way of teaching must be his or her unique invention. Teachers must arrive at this personal invention through their own creative processes in trying to accomplish their teaching goals. As they fail or succeed in reaching these goals, teachers become aware of their deficiencies, defects in their techniques and strategies, and gaps in their knowledge. They draw upon their past experiences. They increase their search for clues in their ongoing experiences. They try to apply creatively the scientifically developed principles they have learned in their professional education and reading. They see things of which they had hitherto been unaware. They start making some hypotheses, testing, and modifying them. Through the pain and pleasure which accompany this process, the teacher's personal invention—his or her way of teaching—evolves.

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